



COLORADO
NEUROLOGICAL
INSTITUTE

Telestroke: Extending Stroke Resources

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Stroke Epidemiology

- ~750,000 Ischemic Strokes Annually in US
- 1 out 15 deaths in U.S due to Stroke
- Leading Cause of Long-term Disability
- Annual Cost is \$58 billion/year
- 63 listed stroke fellowships

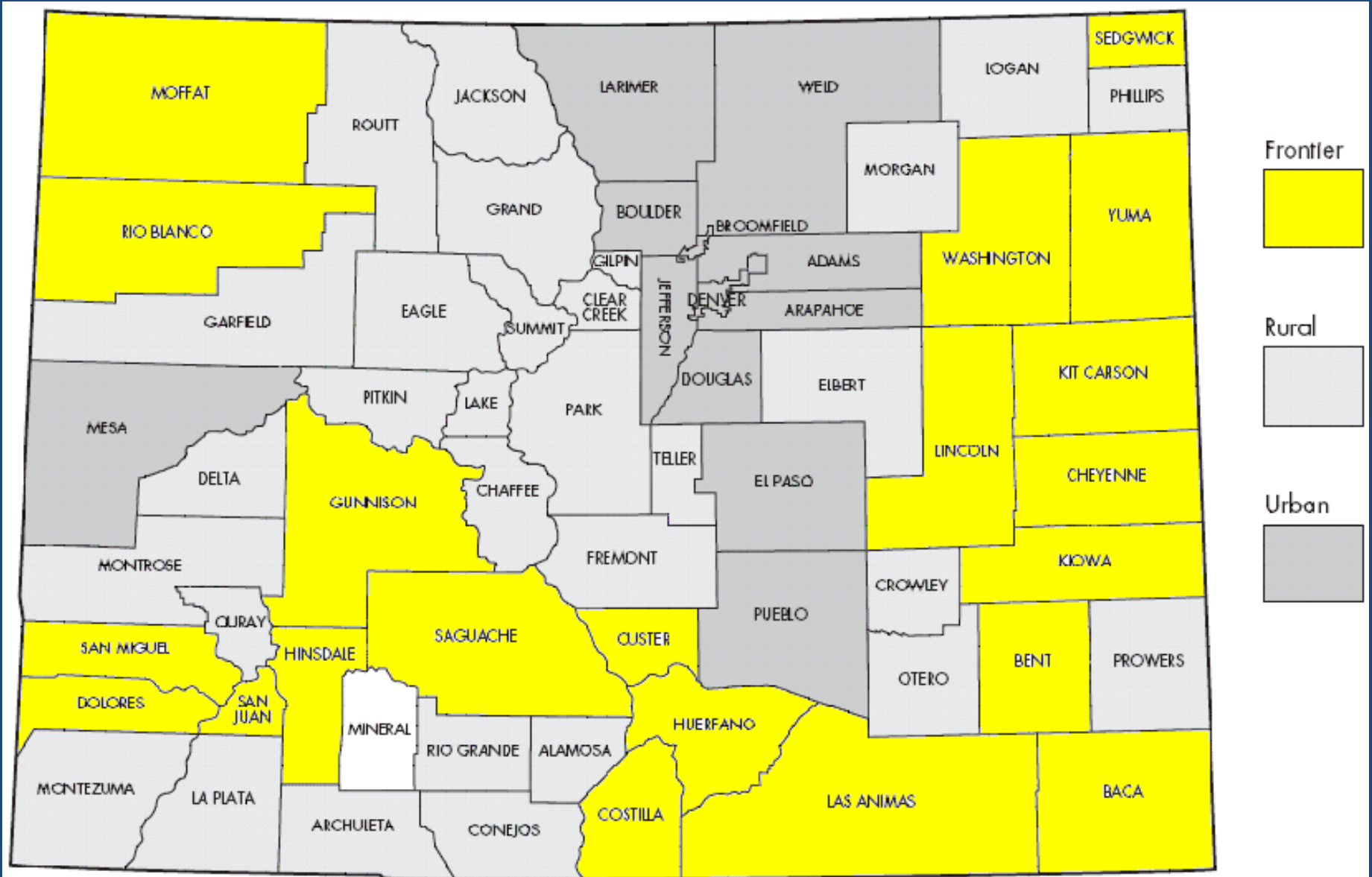
Treatments for Acute Ischemic Stroke

- Intravenous tPA is the only approved therapy
- Extremely Time Sensitive Treatment
- Relatively significant risk of bleeding
- Strict administration criteria

The problems in treating acute stroke patients

- Lack of Organized infrastructure
 - Expeditious CT
 - Neurosurgical Backup
 - Acute Stroke Pathways
- Difficult 24/7 coverage by neurologist willing to treat hyperacute stroke patients
- ER Physicians reluctant to take on burden of treating patients with medication with ICH rate of 6.4%

Colorado



Colorado tPA Use in Ischemic Stroke*

| Year | N | tPA | Ischemic Strokes Treated with tPA |
|------|------|-----|--------------------------------------|
| 1999 | 7739 | 87 | 1.12% |
| 2000 | 7835 | 89 | 1.14% |
| 2001 | 8144 | 89 | 1.10% |

* Ischemic Stroke = ICD9 433-438, 997.02; tPA = ICD9 Proc Code 99.10

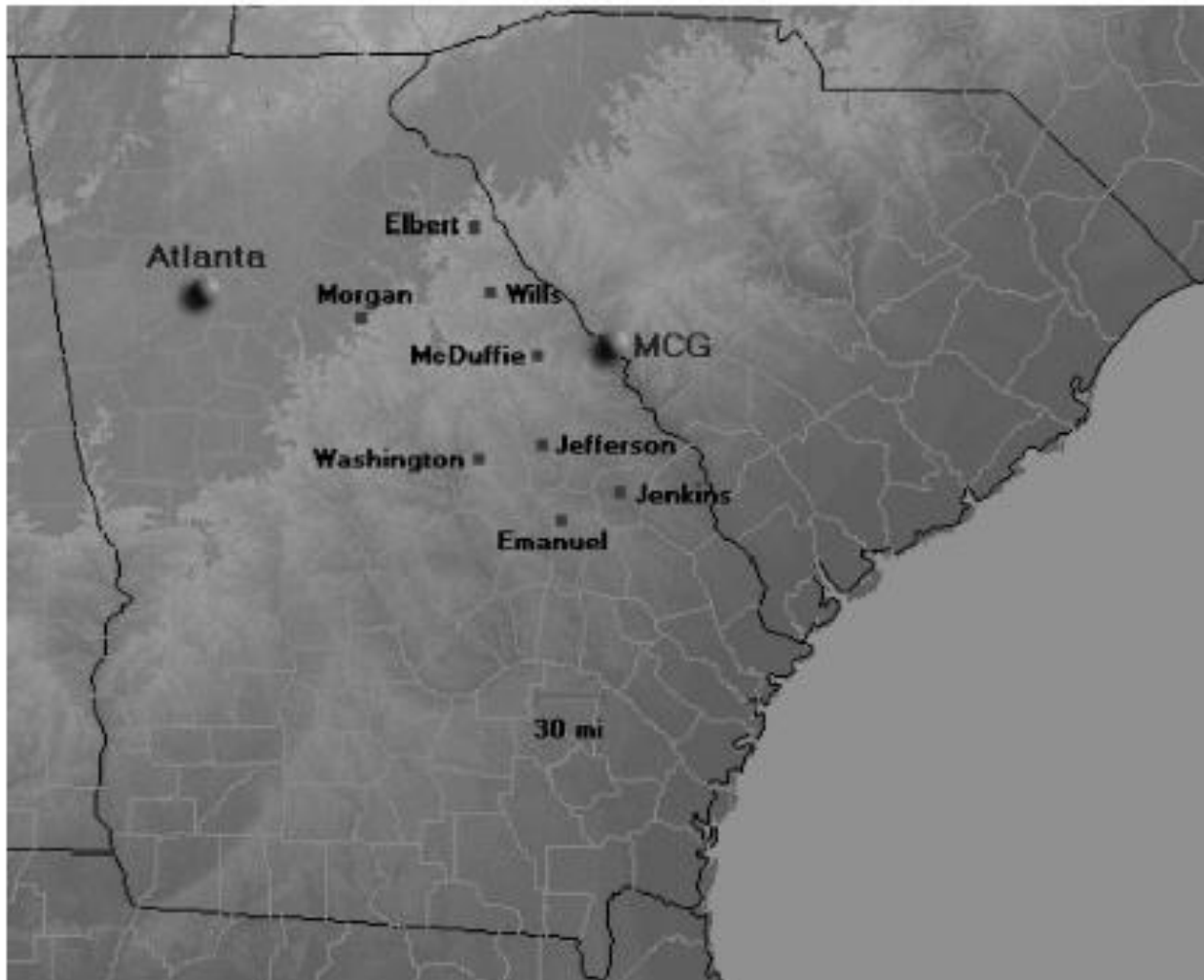
Telemedicine as Solution for Acute Stroke Treatment

- 24/7 Acute Stroke Coverage by Stroke-trained Neurologist
 - Increased comfort level of treating patients with rt-PA
- Remote physician can examine and treat patient independantly
 - Triage much quicker

Does Telemedicine Increase Acute Treatment of Stroke?

- REACH Trial
 - 194 consults in rural Georgia
 - 16% treated with rt-PA
 - Mean Onset to Treatment: 122 minutes

REACH TRIAL



REACH TRIAL

REACH Rural Hospitals

| Hospital | Bed Size | ED Volume | Distance From MCG (in miles) | Black % Population in County |
|-------------------|----------|-----------|------------------------------|------------------------------|
| McDuffie Regional | 47 | 11225 | 32 | 37 |
| Emanuel County | 72 | 10104 | 76 | 33 |
| Wills Memorial | 50 | 6134 | 54 | 43 |
| Washington County | 56 | 8777 | 61 | 53 |
| Jenkins County | 10 | 3312 | 49 | 40 |
| Morgan County | 20 | 4888 | 92 | 30 |
| Jefferson County | 65 | 6252 | 45 | 56 |
| Elbert County | 52 | 7377 | 83 | 51 |

Which is better for decision making in acute stroke consultations?

Telemedicine



Telephone



The Evidence

Efficacy of site-independent telemedicine in the STROKE DOC trial: a randomised, blinded, prospective study

Brett C Meyer, Rema Raman, Thomas Hemmen, Richard Obler, Justin A Zivin, Ramesh Rao, Ronald G Thomas, Patrick D Lyden

Summary

Background To increase the effective use of thrombolytics for acute stroke, the expertise of vascular neurologists must be disseminated more widely. We prospectively assessed whether telemedicine (real-time, two-way audio and video, and digital imaging and communications in medicine [DICOM] interpretation) or telephone was superior for decision making in acute telemedicine consultations.

Methods From January, 2004, to August, 2007, patients older than 18 years who presented with acute stroke symptoms at one of four remote spoke sites were randomly assigned, through a web-based, permuted blocks system, to telemedicine or telephone consultation to assess their suitability for treatment with thrombolytics, on the basis of standard criteria. The primary outcome measure was whether the decision to give thrombolytic treatment was correct, as determined by central adjudication. Secondary outcomes were the rate of thrombolytic use, 90-day functional outcomes (Barthel index [BI] and modified Rankin scale [mRS]), the incidence of intracerebral haemorrhages, and technical observations. Analysis was by intention to treat. This trial is registered with ClinicalTrials.gov, number NCT00283868.

Findings 234 patients were assessed prospectively. 111 patients were randomised to telemedicine, and 111 patients were randomised to telephone consultation; 207 completed the study. Mean National Institutes of Health stroke scale score at presentation was 9·5 (SD 8·1) points (11·4 [8·7] points in the telemedicine group versus 7·7 [7·0] points in the telephone group; $p=0\cdot002$). One telemedicine consultation was aborted for technical reasons, although it was included in the analyses. Correct treatment decisions were made more often in the telemedicine group than in the telephone group (108 [98%] vs 91 [82%], odds ratio [OR] 10·9, 95% CI 2·7–44·6; $p=0\cdot0009$). Intravenous thrombolytics were used at an overall rate of 25% (31 [28%] telemedicine vs 25 [23%] telephone, 1·3, 0·7–2·5; $p=0\cdot43$). 90-day functional outcomes were not different for BI (95–100) (0·6, 0·4–1·1; $p=0\cdot13$) or for mRS score (0·6, 0·3–1·1; $p=0\cdot09$). There was no difference in mortality (1·6, 0·8–3·4; $p=0\cdot27$) or rates of intracerebral haemorrhage after treatment with thrombolytics (2 [7%] telemedicine vs 2 [8%] telephone, 0·8, 0·1–6·3; $p=1\cdot0$). However, there were more incomplete data in the telephone group than in the telemedicine group (12% vs 3%, 0·2, 0·1–0·3; $p=0\cdot0001$).

Interpretation The authors of this trial report that stroke telemedicine consultations result in more accurate decision making compared with telephone consultations and can serve as a model for the effectiveness of telemedicine in other medical specialties. The more appropriate decisions, high rates of thrombolysis use, improved data collection, low rate of intracerebral haemorrhage, low technical complications, and favourable time requirements all support the efficacy of telemedicine for making treatment decisions, and might enable more practitioners to use this medium in daily stroke care.

STRoKE DOC Trial

- Objective – to assess whether telemedicine or telephone was superior for decision making in acute stroke consultations
- Study Design – Randomized Controlled Trial
- Setting – 4 remote hospitals linked to an academic hub
- Patients – 222 acute stroke patients presenting to remote hospitals were randomized to telemedicine or telephone stroke consults with hub stroke neurologists

Telephone Arm

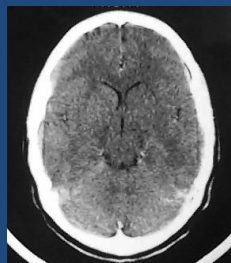


- Hub consultant queried spoke practitioner of
 - History
 - Physical exam
 - Labs
 - Radiologist report of CT
 - Directed local practitioner in NIHSS exam
- Head CT images NOT available

Telemedicine Arm



- Hub Consultant turned on camera → took history & conducted NIHSS
- Other exam findings done by or reported to the consultant
- Head CT images available





tPA or no tPA



Did the Hub
consultant
make the
correct
decision?

Results – determining tPA eligibility

| | Telemedicine n = 110 | Telephone n = 111 | O.R. | p |
|---|---------------------------------|------------------------------|-----------------------------|----------------------------|
| Overall correct decision Level 2b (SDAC) | 108 (98%) | 91 (82%) | 10.9 (2.7- 44.6) | 0.0009 (0.0001) |

Correct treatment decisions made more often in telemedicine group than telephone-only group

Practical Interpretation of Data

- When neurologists decide that patients are thrombolytic candidates by telephone, they are largely correct
 - The telephone capable of screening out mimics
- When neurologists decide that patients are not thrombolytic candidates by telephone, they make many errors
 - The telephone-only results in under-treating of eligible candidates and telemedicine does much better
 - ‘minor deficit, rapid improvement’ issue is better evaluated with camera

CO-DOC Review

- Goal: To Provide Stroke Center Level Care for Acute Stroke Patients in Rural and Underserved Areas
- 1st Consult Performed May 30th, 2006
- Site Expansion in Rural and “Underserved Sites” ongoing!

CO-DOC Telemedicine



Neurologist



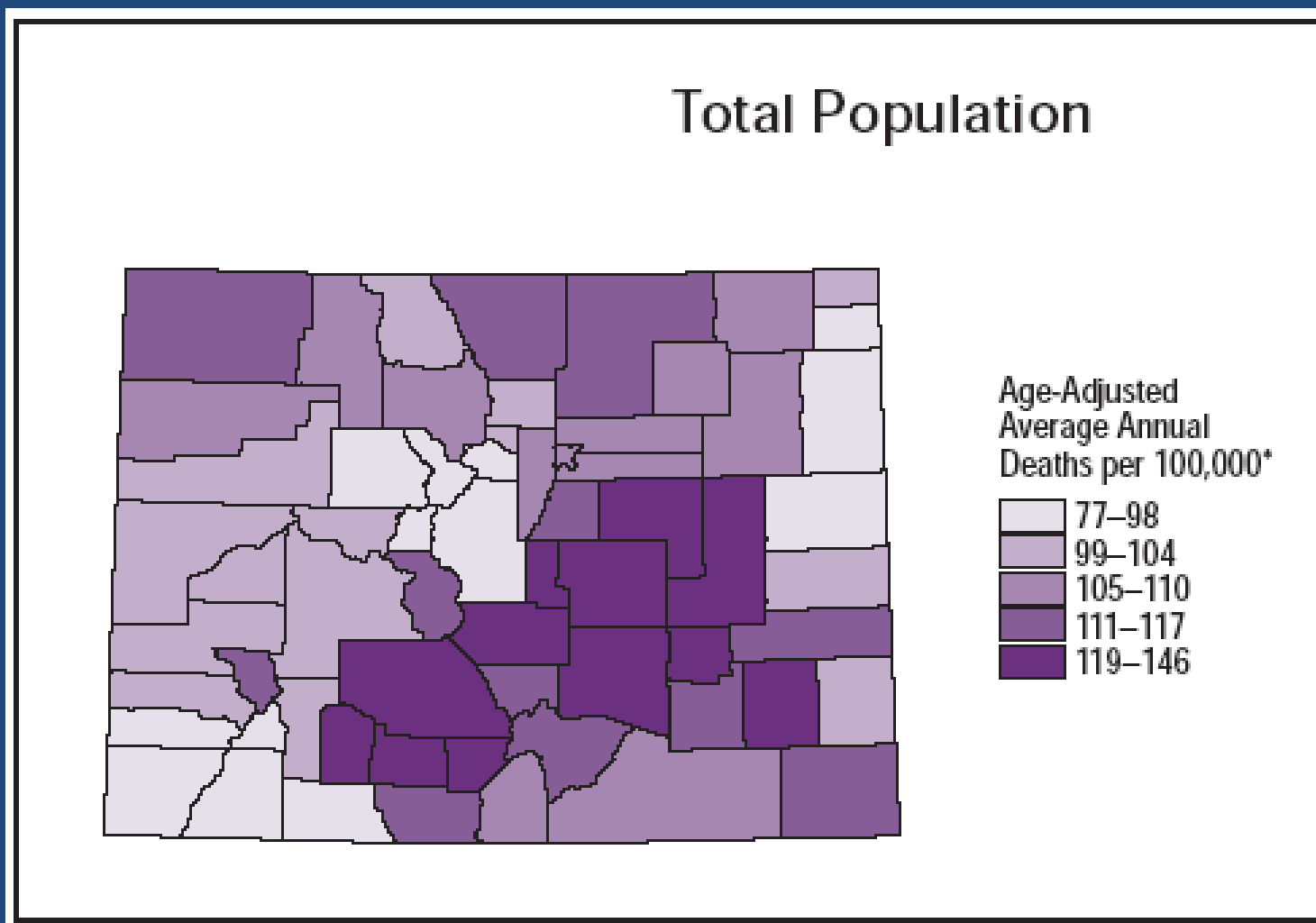
Participating Hospital



CNI Telemedicine Project

- Colorado State Grant Approved for 5 Sites
- Identify High stroke incidence areas of Colorado
 - Little to no Acute Stroke Coverage
- Geographical Distribution of the State
- Areas of Population Growth
 - Potential At-Risk Stroke Patients

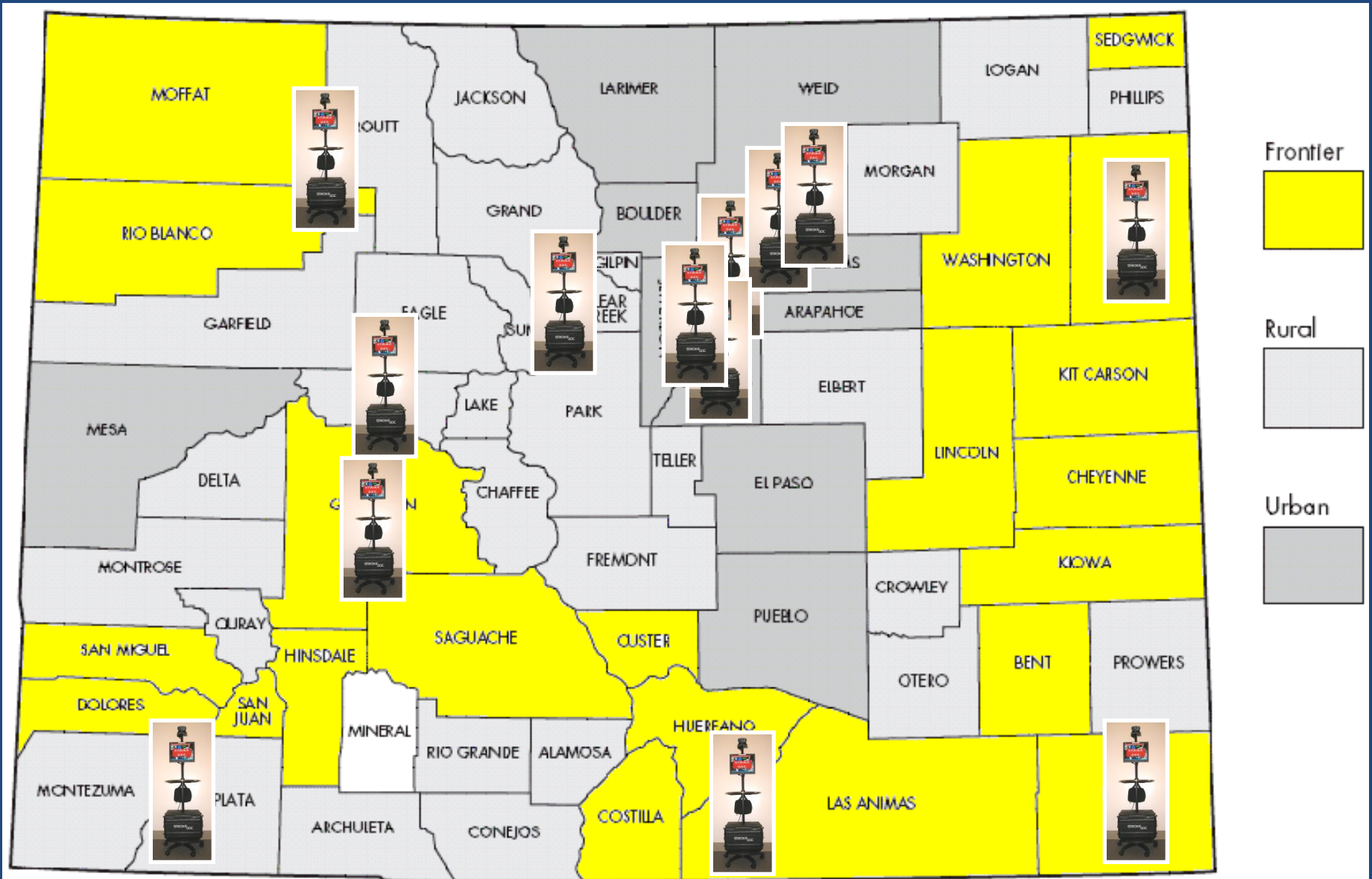
Stroke Death Rates, 1991–1998



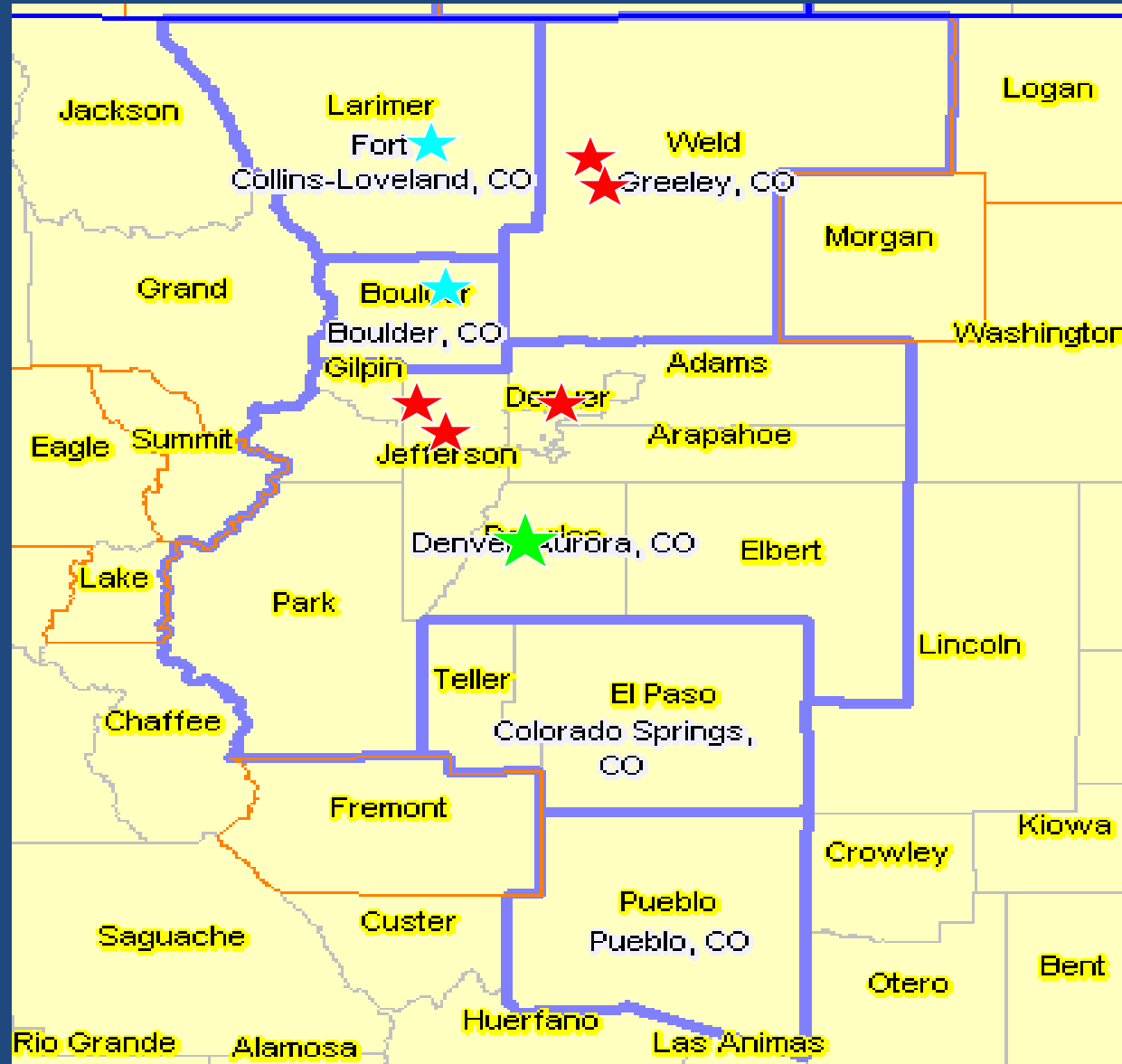
CO-DOC Telemedicine Sites

- Springfield
- Yuma
- Trinidad
- Gunnison
- Leadville
- Rangeley
- Thornton
- Vail
- Greeley (2)
- Durango
- Aspen
- Lutheran Medical Center (2)
- **Mckee Medical Center (2)**
- **Longmont United Hospital**
- **Good Samaritan Hospital (2)**

Colorado



CO-DOC in Denver Metropolitan Area



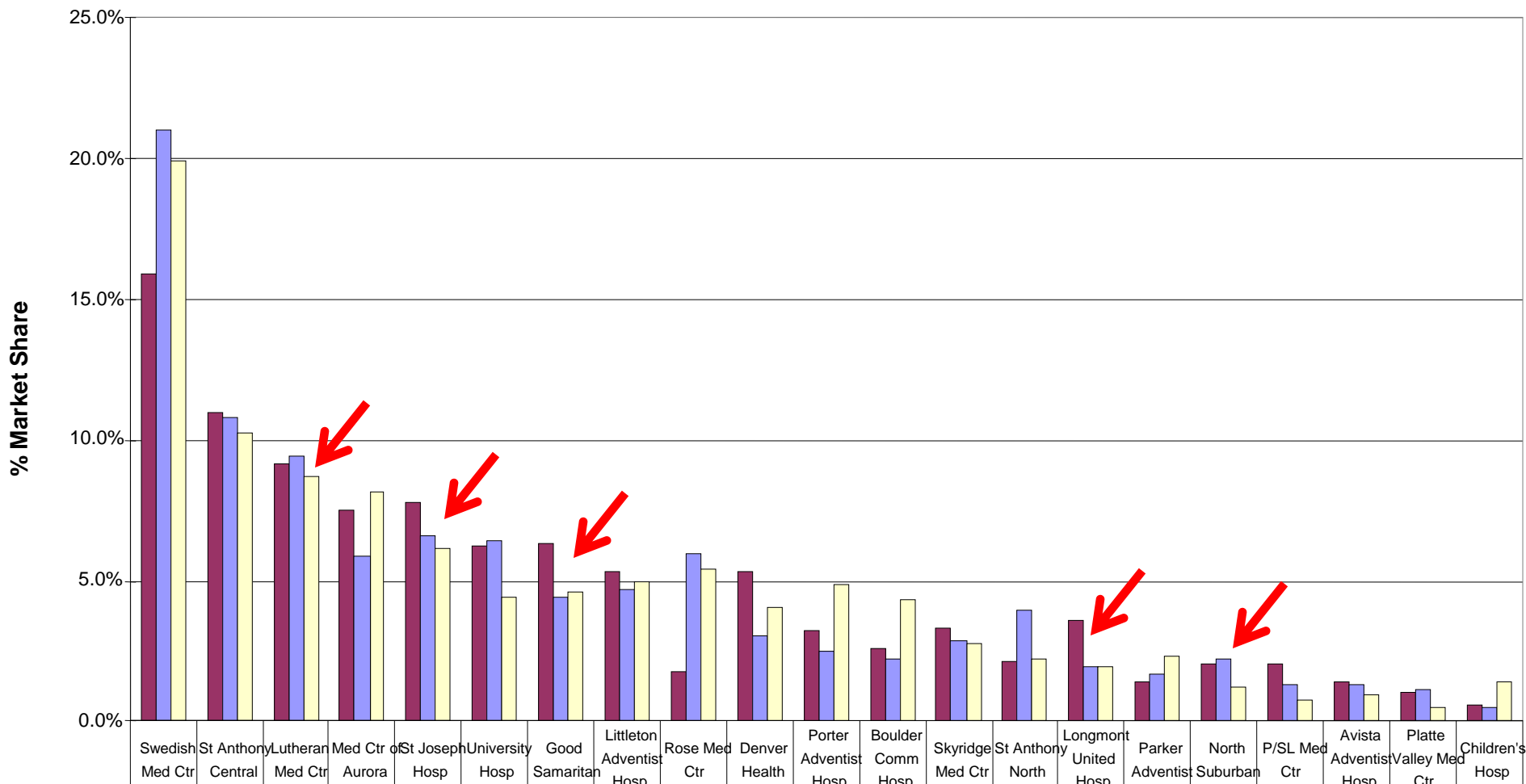
Telemedicine Host Hospitals



Telemedicine Sites in Progress

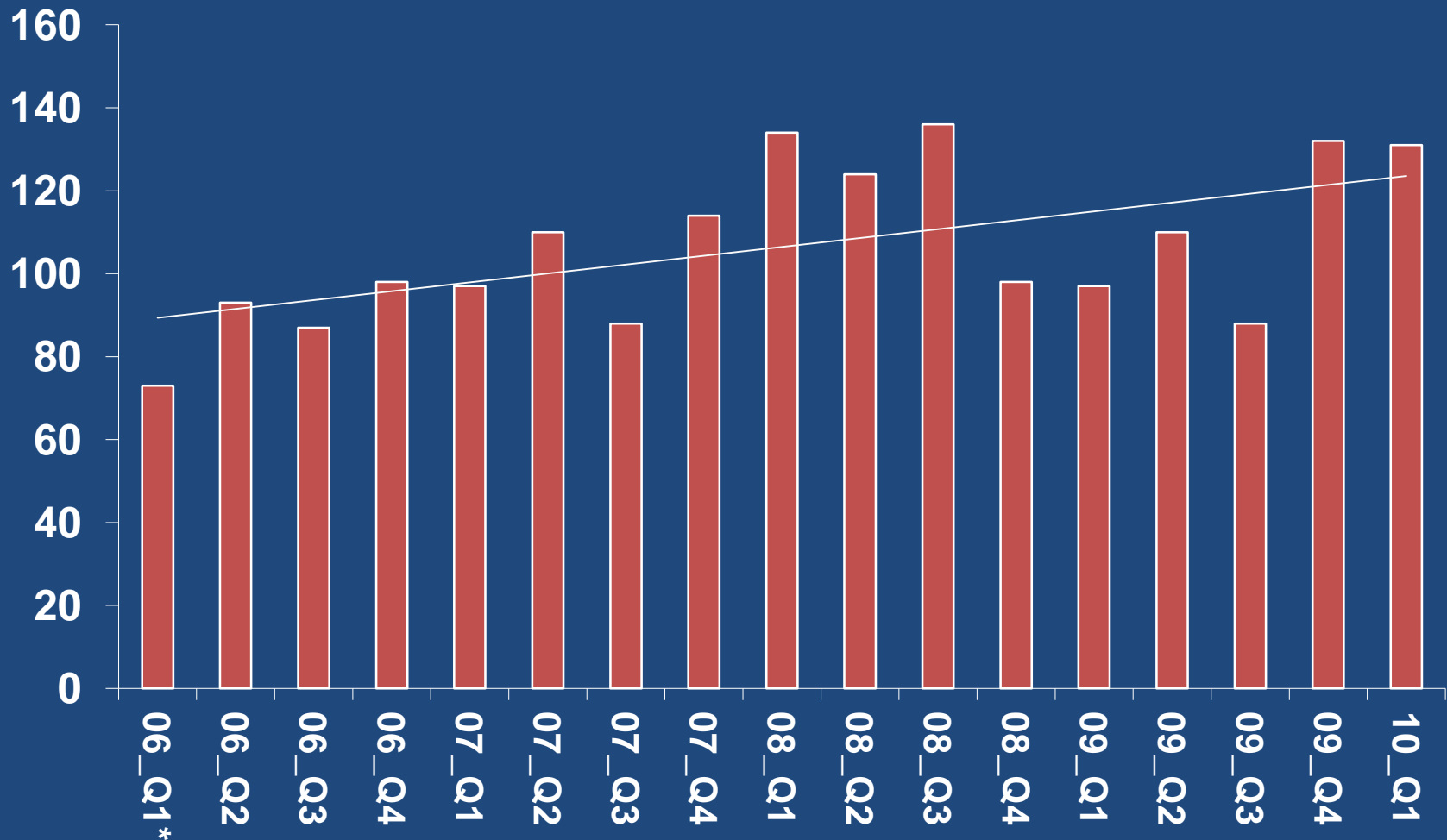


Telemedicine Hub Location



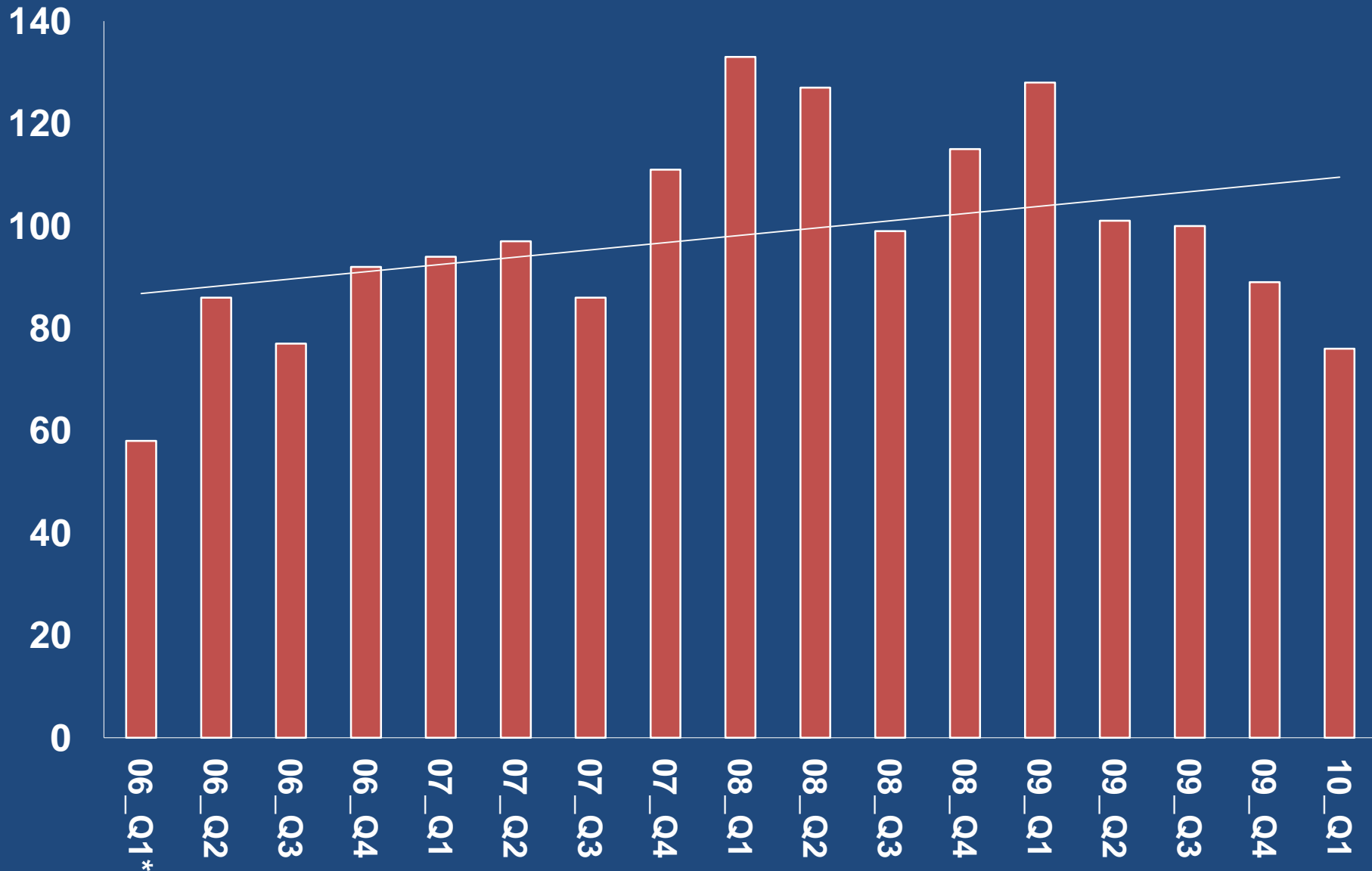
| | | | | | | | | | | | | | | | | | | | | | |
|--------------------|-------|-------|-------|--------|-------|--------|--------|-------|--------|--------|--------|-------|-------|--------|--------|-------|--------|--------|--------|--------|--------|
| % Mkt Share 2007 | 15.9% | 11.0% | 9.1% | 7.5% | 7.8% | 6.2% | 6.4% | 5.4% | 1.7% | 5.4% | 3.2% | 2.6% | 3.3% | 2.2% | 3.6% | 1.4% | 2.0% | 2.0% | 1.4% | 1.0% | 0.6% |
| % Mkt Share 2008 | 21.0% | 10.8% | 9.4% | 5.9% | 6.7% | 6.4% | 4.4% | 4.7% | 6.0% | 3.0% | 2.5% | 2.2% | 2.9% | 3.9% | 2.0% | 1.7% | 2.2% | 1.3% | 1.3% | 1.2% | 0.5% |
| % Mkt Share 2009 | 19.9% | 10.2% | 8.7% | 8.1% | 6.2% | 4.5% | 4.6% | 5.0% | 5.4% | 4.1% | 4.9% | 4.3% | 2.8% | 2.2% | 2.0% | 2.4% | 1.2% | 0.8% | 0.9% | 0.5% | 1.4% |
| Cases 2007 | 110 | 76 | 63 | 52 | 54 | 43 | 44 | 37 | 12 | 37 | 22 | 18 | 23 | 15 | 25 | 10 | 14 | 14 | 10 | 7 | 4 |
| Cases 2008 | 161 | 83 | 72 | 45 | 51 | 49 | 34 | 36 | 46 | 23 | 19 | 17 | 22 | 30 | 15 | 13 | 17 | 10 | 10 | 9 | 4 |
| Cases 2009 | 152 | 78 | 66 | 62 | 47 | 34 | 35 | 38 | 41 | 31 | 37 | 33 | 21 | 17 | 15 | 18 | 9 | 6 | 7 | 4 | 11 |
| % Chng Cases 07-08 | 46.4% | 9.2% | 14.3% | -13.5% | -5.6% | 14.0% | -22.7% | -2.7% | 283.3% | -37.8% | -13.6% | -5.6% | -4.3% | 100.0% | -40.0% | 30.0% | 21.4% | -28.6% | 0.0% | 28.6% | 0.0% |
| % Chng Cases 08-09 | -5.6% | -6.0% | -8.3% | 37.8% | -7.8% | -30.6% | 2.9% | 5.6% | -10.9% | 34.8% | 94.7% | 94.1% | -4.5% | -43.3% | 0.0% | 38.5% | -47.1% | -40.0% | -30.0% | -55.6% | 175.0% |

Ischemic Strokes



*Incomplete Quarters

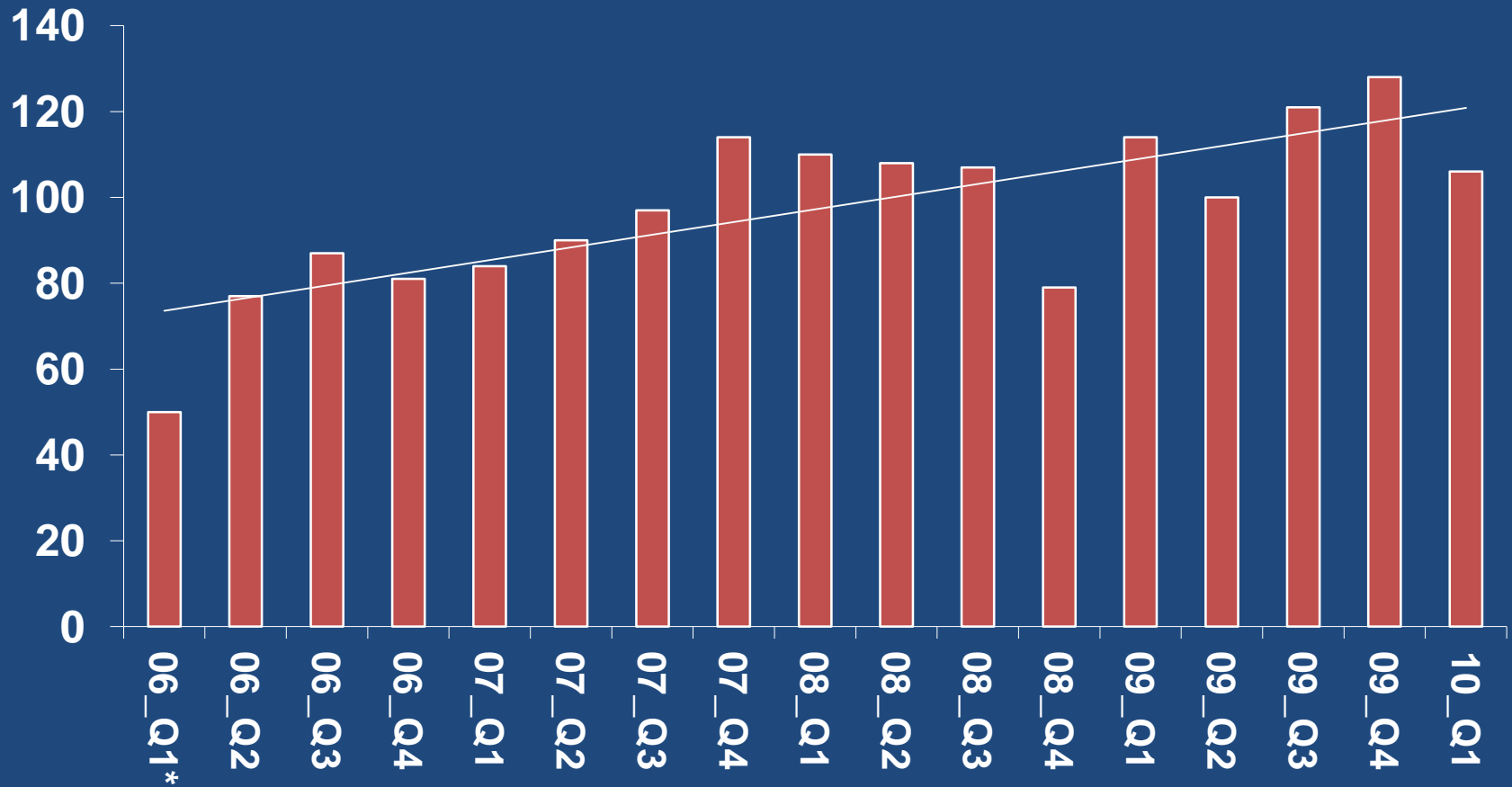
Stroke Alerts



*Incomplete Quarter

Includes stroke alerts called by EMS, ED, Transfer, Inpt

Transfers



*Incomplete Quarters

Top 10 Stroke Transfer Facilities

2010

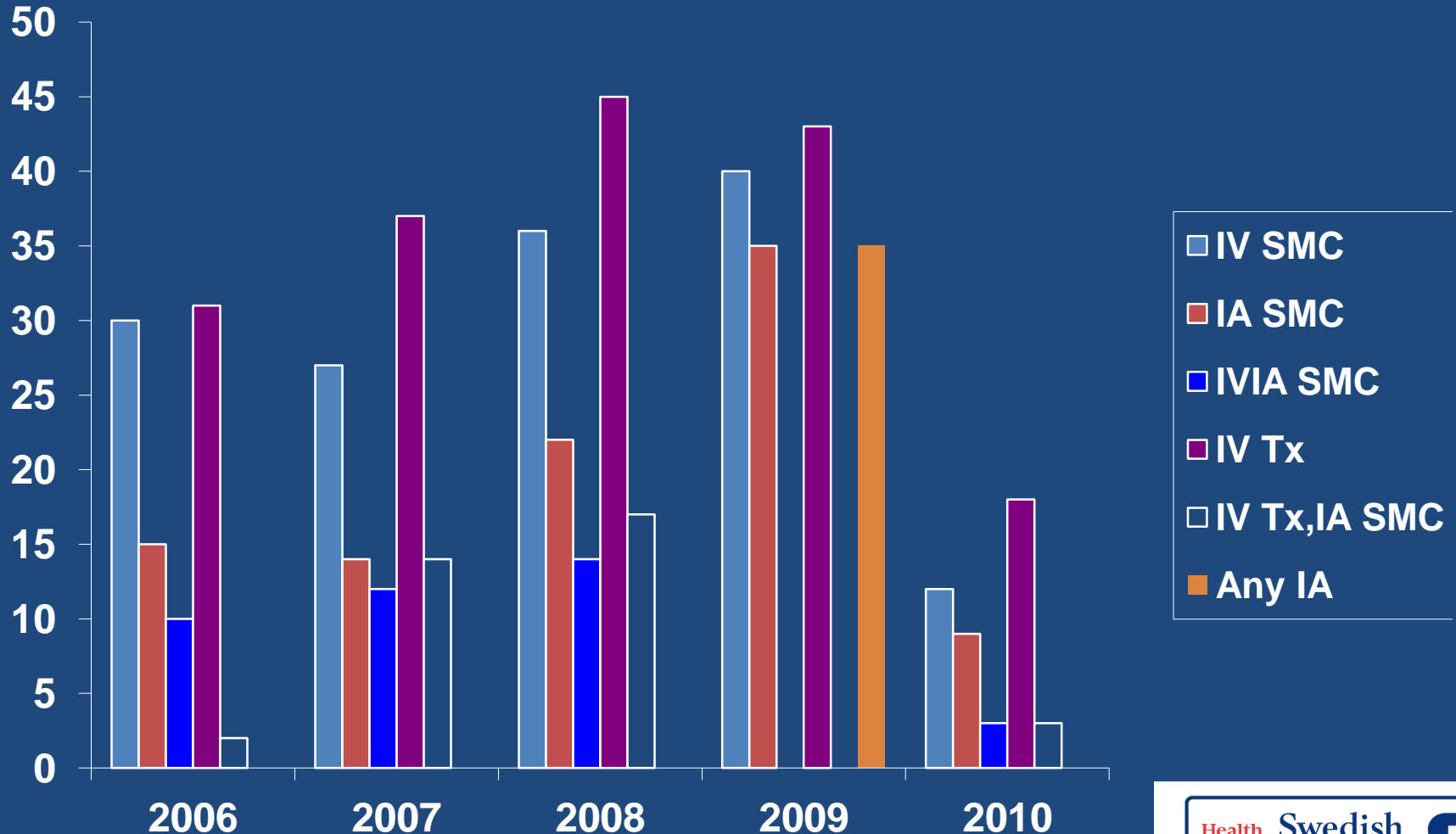
- North Sub 18
- SWER 14
- Vail 10
- Lutheran 6
- Memorial 6
- Durango 6
- Greeley 6
- Sterling 5
- McKee 4
- Aurora-South 4

2009

- North Sub 54
- SWER 26
- Durango 23
- Memorial 19
- Vail 17
- Salida 14
- St. Joes 9
- Rose 8
- 10 tie for 7

Green = Telemedicine Sites

Acute Stroke Treatments

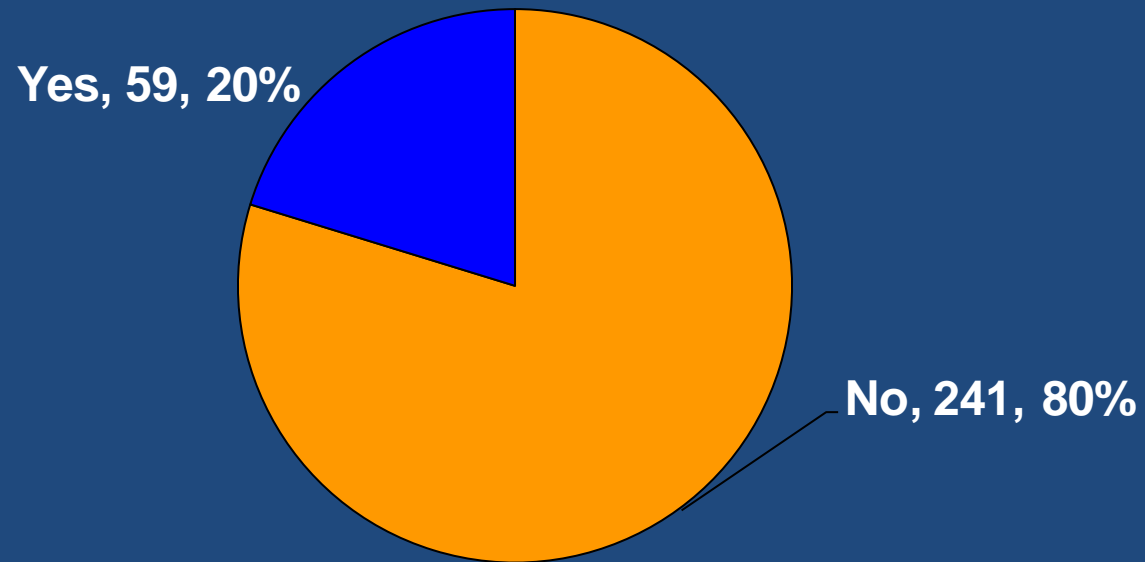


Stroke Golden Hour Stats

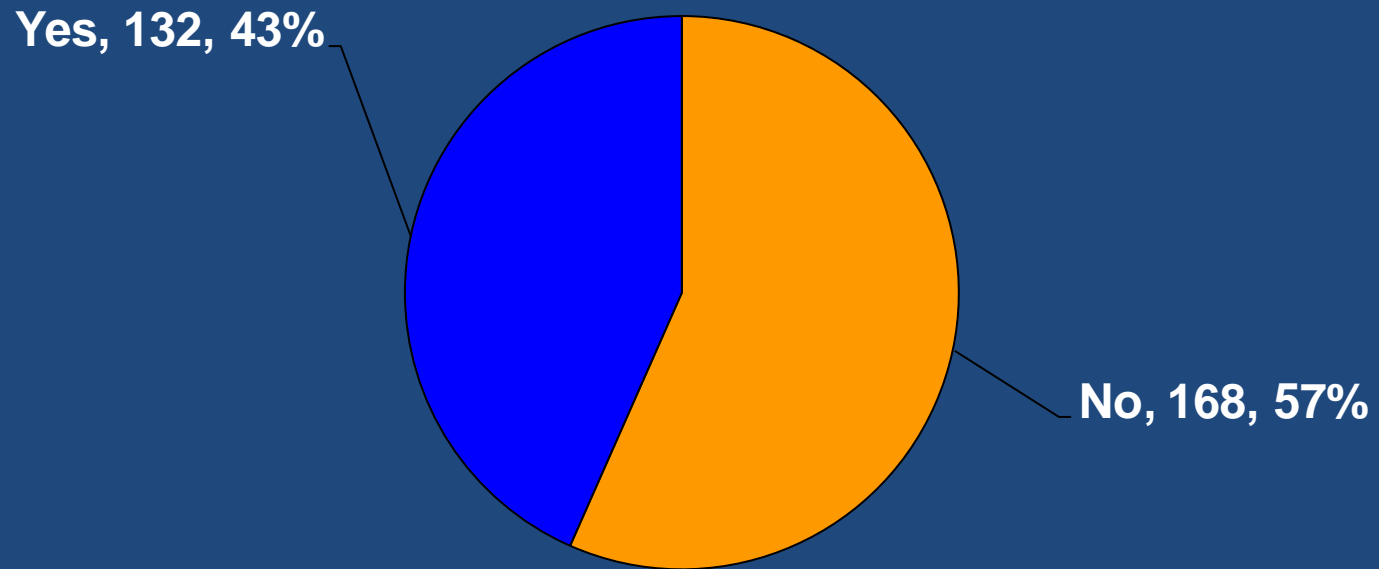
| | SWEDISH 2010 | SWEDISH 2009 | COLORADO 2009 |
|---|--------------|--------------|---------------|
| Ave Door to tPA time | 47 min | 49 min | 80 min |
| Ave Door to CT time | 18 min | 15 min | 84 min* |
| Ave Door to Neurologist time | 5 min | 6 min | 510 min** |
| % Eligible for tPA Treated | 100% | 100% | 71.3 % |
| % Treated in < 60 minutes | 87% | 86% | 35.5% |
| % Total treated with IV t-PA | 27% | 14% | 6% |
| % Total treated with any acute intervention | 34% | 20% | 7.6% |
| sICH Rate | 6.0% | 3.2% | 5.3% |

*Stroke pts who arrive < 3 hrs **Stroke Team Arrival

Treated with TPA?



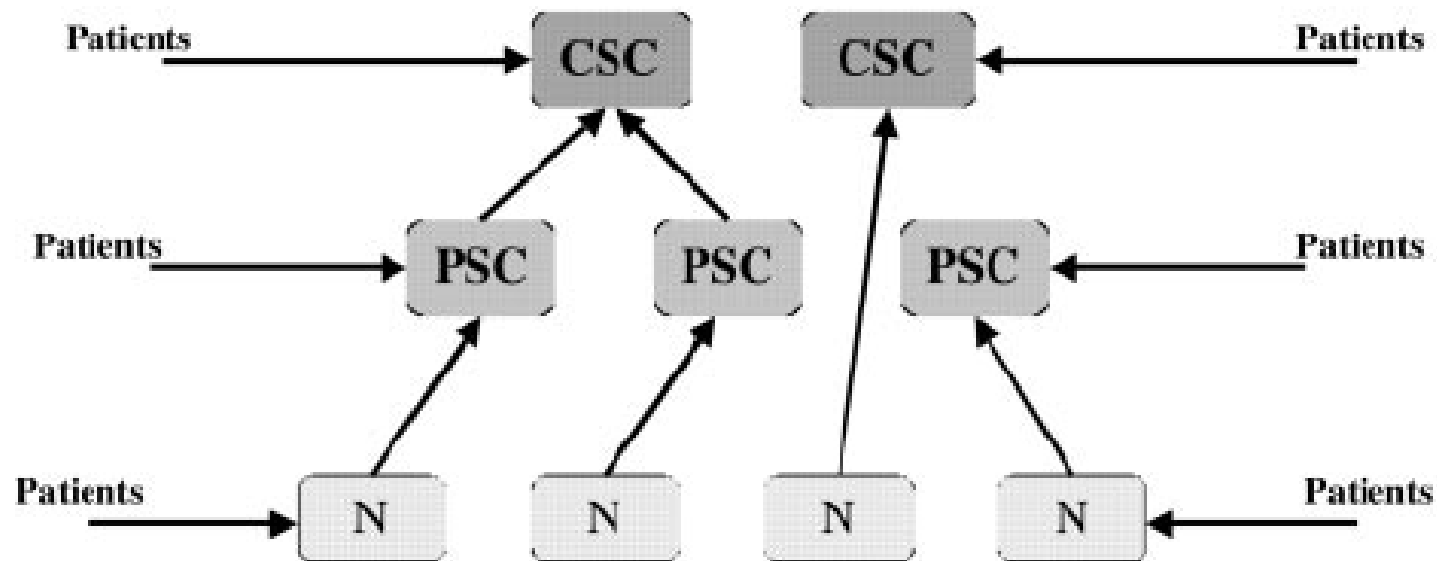
Transferred?



Future of Telemedicine

- Extended Coverage throughout state
 - Continue to Expand Rural Access
 - Expand Outside Hospital System Networks
 - Major Population Areas
 - Lots of neurologists, not many willing and able to cover for Acute Stroke Issues
- Expand Coverage Networks into Surrounding Regions

Organization of Stroke Centers in a Hospital Network or Geographical Area



“Within such a network or system, one approach to acute stroke care might be to designate some hospitals as PSCs and others as CSCs (Figure). This approach would allow for patients, equipment, and expertise to be concentrated at specific hospitals rather than spread throughout the entire network. This is quite similar to the paradigm used for other complex diseases that require a multidisciplinary team approach such as trauma, cancer, severe burns, and organ transplantation.”

Colorado

Frontier

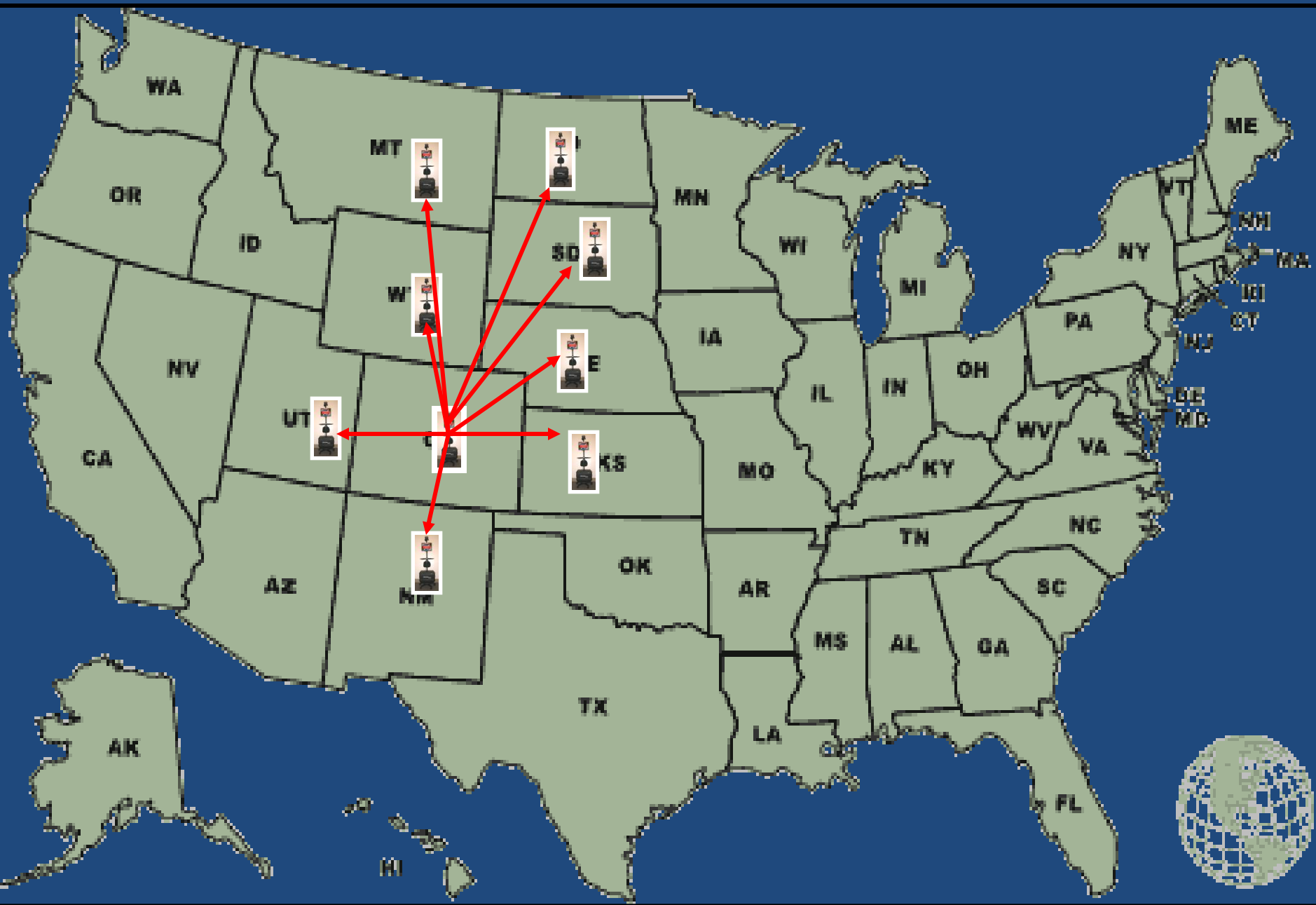
Rural

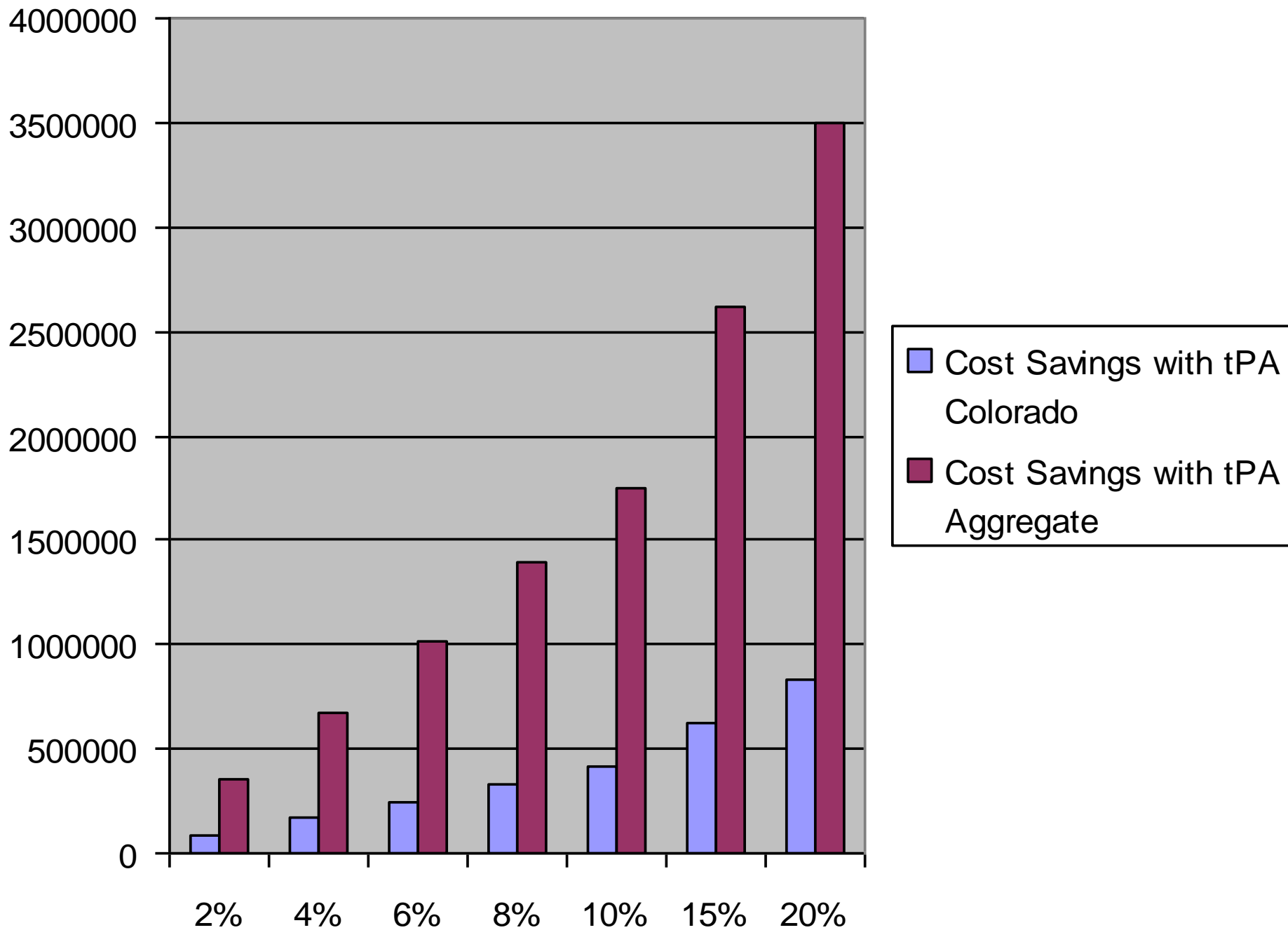
Urban



Cost Savings with tPA

| | Annual No. of Ischemic Strokes | Proportion of Ischemic Stroke Patients That Receive tPA (%) | | | | | | |
|---------------|--------------------------------------|---|--------------|--------------|--------------|--------------|--------------|--------------|
| | | Cost Savings in First Year Post-Stroke (American \$) | | | | | | |
| | | 2% | 4% | 6% | 8% | 10% | 15% | 20% |
| NATION | | | | | | | | |
| United States | 616 000 | \$7 392 000 | \$14 784 000 | \$22 176 000 | \$29 568 000 | \$36 960 000 | \$55 440 000 | \$73 920 000 |
| Kansas | 6 975 | \$ 84 000 | \$ 168 000 | \$ 252 000 | \$ 336 000 | \$ 420 000 | \$ 630 000 | \$ 840 000 |
| Colorado | 6 888 | \$ 82 800 | \$ 165 600 | \$ 248 400 | \$ 331 200 | \$ 414 000 | \$ 621 000 | \$ 828 000 |
| Nebraska | 4 265 | \$ 51 600 | \$ 103 200 | \$ 154 800 | \$ 206 400 | \$ 258 000 | \$ 387 000 | \$ 516 000 |
| Nevada | 3 446 | \$ 42 000 | \$ 84 000 | \$ 126 000 | \$ 168 000 | \$ 210 000 | \$ 315 000 | \$ 420 000 |
| Utah | 3 284 | \$ 39 600 | \$ 79 200 | \$ 118 800 | \$ 158 400 | \$ 198 000 | \$ 297 000 | \$ 396 000 |
| New Mexico | 3 110 | \$ 37 200 | \$ 74 400 | \$ 111 600 | \$ 148 800 | \$ 186 000 | \$ 279 000 | \$ 372 000 |
| Montana | 2 181 | \$26 400 | \$52 800 | \$79 200 | \$105 600 | \$132 000 | \$198 000 | \$264 000 |





Issues with Telemedicine and Widespread Acceptance

- Physician Liability
 - Who is Liable
 - Which state?
- Credentialing:
 - Intra and Interstate
- Standards of Care
- Financial Reimbursement
 - Medicare/Medicaid
 - Retainer model?
- Common Technology Standards

CO-DOC/Mastercard

- Total Cameras Covered: 19
- Number of Beds Covered on call: 2132
- Number of Neurologists on call: 1
- Telemedicine calls: 1.3
- Total Miles Traveled: 0
- Being able to do consults in shorts and a T-shirt: Priceless

A photograph of a sky at sunset or sunrise. The sky is a deep blue at the top, transitioning to a lighter blue and then a warm orange near the horizon. There are several layers of clouds. The top layer consists of thin, wispy white clouds. Below that is a thicker layer of greyish-blue clouds. Near the horizon, there is a bright, glowing band of light where the sun is setting or rising, with several distinct sunbeams (crepuscular rays) fanning out upwards through the clouds. In the bottom left corner, there is a large, dark, and dense cloud formation.

The Limit??